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Information Systems Equipment Division
Phoenix, Arizona

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TITLE: ENGINEERING PRODUCT SPECIFICATION, PART 1
PRT300 HIGH SPEED LINE PRINTER SUBSYSTEM

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1.3 PHYSICAL SUBSYSTEM CONFIGURATION (Continued)

The arrangement illustrated shall be used for all new installations.

Existing installations, which replace existing printers with the PRT300, require alternatives to the standard two unit configuration. Therefore, the maximum cable length between controller and device (connector to connector) shall be 30 feet.

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Accessibility, for maintenance, shall be limited to the sides of the controller unit, but shall be permitted on all four sides of the device.

1.3.1 The life of the PRT300 Subsystem closely parallels that of the 655 and 355 Central Processors (and Systems) of the 1970's.

1.3.1.1 Therefore, the producing department should consider the use of integrated circuit technology for implementing the PRT300 Controller. This approach would be consistent with the technology for these processors, aid in achieving reliability goals, standardize spare parts, and enhance maintainability through use of the MQX Board Tester for fault analysis. Therefore, the same integrated circuit set (the same I.C. chips) and printed wiring board specifications used by 655 and 355 processors should be considered. The aforementioned is not intended to exclude the use of hybrid circuits, or other special circuits and components where an obvious need exists, nor does it limit implementation of the PRT300 Controller to MQX integrated circuit technology.

1.3.1.2 The device with its associated device oriented electronics is to be supplied by a vendor, and is already designed and built. Therefore, I.C. technology consistent with the 355 and 655 central processors obviously does not apply to the vendor supplied electronics. However, all electronics designed by General Electric, and located within the device, shall be subject to the same guidelines outlined for the controller.

1.4 FUNCTIONAL DESCRIPTION

- (a) The PRT300 Printer Subsystem shall be an on-line (external user controlled) output device.
- (b) The Subsystem shall print first, then slew a given number of lines specified by the external user.
- (c) The design shall permit character sets to be changed easily by computer operations personnel.

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1.6 REFERENCE DOCUMENTS

Functional Specification Addendum	#69-002 August 29, 1969
Common Peripheral Interface	43A130524 - Revision H
Standard Character Sets	43A174506
VFU Loop Specification	43B136222
600 System Operator's Manual	CPB-1045C
PRT 300 Operator's Manual	CPB-1692
Proposed Standards (IDD)	
01.08 Environment	
01.09 General Product Safety	
01.10 Equipment Handling	
01.47 (UL 478)	
01.48 Primary Power	
01.49 Glossary	
Documentation	M50EB00177
Purchase Specification (Control Data Corporation)	43A174548
600 Systems T&D Guidelines	43A164514
600 Monitor II	43A155937
600 OPTS 600	43A155998
400 System Test Guide	43A138861
400 T&D Programming Guide	43A214225
400 Test Monitor	43A129796

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2.1.4 Print Line Buffer

The subsystem shall be required to buffer a complete print line before printing begins. The buffer shall be 8-bit byte oriented, and contain checking circuits to ensure data validity on readout. Data shall be requested from the external user at a maximum character rate of 55.5 KC (18 microseconds per character). However, in order to further reduce the impact of the data transfer on the external user, the printer shall be capable of waiting approximately 220 to 460 milliseconds for a character.

2.1.5 Print Line Buffer/Image Buffer

In effect, the train image buffer, representing the physical train in motion, is compared (at one character instant) with the character contained in the print line buffer, for the column (hammer) next in position to be printed. If a match is made, the print hammer is fired at the proper time. The process is repeated for the next hammer to come into position.

2.1.6 Print Speed

The PRT300 shall buffer a line of characters and then print the line of data at the maximum possible rate, asynchronous to the external user system. Print speed is a function of train speed, paper slew time, the length of the character set, and the number of times a character is repeated on the train.

Some typical print areas, in lines per minute (LPM) and with a single line slew, are as follows:

<u>Character Set</u>	<u>Character Repeat Rate</u>	<u>Nominal Print Rate LPM</u>	<u>Burst Print Rate LPM</u>
16	18	1500	2500
48	6	1150	No Burst
63*	(Variable)	1052	No Burst
94	3	670	No Burst

*Estimated print rate based on field data on character usage.

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2.1.6 Print Speed (continued)

The maximum print rate obtainable in bursts of five minutes shall be 2500 LPM, with gradual reduction to nominal rate in sustained printing thereafter.

Burst speed is a function of temperatures internal to the mechanism as well as the character set. After an initial burst, it may be some time before another burst can be effected at the same high rate until temperature sensing elements indicate the mechanism has cooled off.

The print speed may be considerably above these nominal rates for short periods of time, depending upon the configuration of the character set, and the utilization of the different characters within the set.

2.1.7 Slew Speed

The device contains a two speed paper drive mechanism.

- (a) For paper slews of 2 lines or less, the maximum slew speed is 28 ± 5 inches per second.
- (b) For continuous slews greater than 2 lines, the nominal rate is 70 ± 5 inches/second in the 6 lines per inch mode, and 60 ± 5 inches/second in 8 lines per inch mode. The paper slew rate shall be within 90% of the continuous rate in 20 milliseconds or less.
- (c) The following table summarizes the nominal slew characteristics, and is intended to illustrate that a finite time is required to reach maximum slew speed.

NUMBER OF LINES	6* LINES/INCH	8* LINES/INCH
1	12 millisecs	10 millisecs
2	18	15
3	23	19
4	26	21
6	31	25
12	44	37
18	59	50
30	87	75

*Nominal slew time only. Does not include print time.

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2.1.7 Slew Speed (continued)

(d) If two successive page eject functions occur within two seconds, it is recognized that the high speed slew for the second page eject may require a speed reduction in order to permit proper form stacking.

2.1.8 Print Positions

There shall be 136 print positions available. It shall be possible to print in any or all of these positions on one print line.

2.1.9 Print Spacing

Horizontal - 10 characters per inch.
Vertical - 6 or 8 lines per inch under operator control.

2.1.10 Font

The producing department shall determine the standard type font best suited to the unique characteristics of a horizontally moving type slug. Bar fonts such as COC-5 and CMC-7, will not be offered on this subsystem (see paragraph 1.4h).

2.1.11 Standard & Special Character Sets

Refer to drawing 43A174506 - Type Array Cartridge Assembly (Purchase Specification) for more details.

2.1.11.1 Standard 63 Character Set

The Standard non-ASCII character set shall consist of the following 63 printable characters, plus a non-printable "space" character:

<u>Characters</u>	<u>Octal (6 bit) Code</u>
Numerals 0 through 9	00 - 11
Left square bracket ([)	12
Number sign (#)	13
At sign (@)	14
Colon (:)	15
Greater than sign (>)	16
Question Mark (?)	17

NOTE: The 63 character set shall be arranged on the train cartridge per drawing 43A174506 (Group 001).

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2.1.11.1 Standard 63 Character Set (cont.)

<u>Characters</u>	<u>Octal (6 bit) Code</u>
Space (non-printable)	20
Alphabetic Characters A through I	21 - 31
Ampersand (&)	32
Period (.)	33
Right square bracket (])	34
Open Parenthesis (	35
Less than sign (<)	36
Left slash (\)	37
Arrow up (↑)	40
Alphabetic Characters J through R	41 - 51
Hyphen (-)	52
Dollar (\$)	53
Asterisk (*)	54
Close parenthesis)	55
Semi-Colon (;)	56
Apostrophe (')	57
Plus sign (+)	60
Right slash (/)	61
Alphabetic Characters S through Z	62 - 71
Left Arrow (←)	72
Comma (,)	73
Percent Sign (%)	74
Equal sign (=)	75
Quotation marks (")	76
Exclamation point (!)	77

2.1.11.2 Standard 96 Character Set

A USASCII standard character set (7 bit code) shall consist of 94 printable characters, plus non-printable space and delete characters. The characters and codes shall conform to the following:

<u>Characters</u>	<u>Octal (7 bit) Code</u>
Space (no print)	040
Exclamation mark (!)	041
Quotation marks (")	042
Number sign (#)	043
Dollar sign (\$)	044
Percent (%)	045
Ampersand (&)	046

NOTE: The 94 character set shall be arranged on the train cartridge per drawing 43A174506 (Group 002).

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2.1.11.2 Standard 96 Character Set (cont.)

<u>Characters</u>	<u>Octal (7 bit) Code</u>
Apostrophe or closing single quotation mark (')	047
Open parenthesis (	050
Close parenthesis)	051
Asterisk (*)	052
Plus (+)	053
Comma (,)	054
Hyphen (-)	055
Period (.)	056
Right slant (/)	057
Numerals (0-9)	060 - 071
Colon (:))	072
Semicolon (;)	073
Less than (<)	074
Equals (=)	075
Greater than (>)	076
Question mark (?)	077
At sign (@)	100
Alphabet (A-Z) (upper case)	101 - 132
Opening bracket ([)	133
Left slant (\)	134
Closing bracket (])	135
Circumflex (^)	136
Underline (_)	137
Grave accent (`)	140
Alphabet (a-z) (lower case)	141 - 172
Opening brace ({)	173
Vertical dash ()	174
Closing brace (})	175
Tilde (~)	176
Delete (non-printable)	177

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2.1.11.3 Special 16 Character Set

The character set shall consist of the following 16 printable characters plus a "space" (no print):

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, comma, period, -, *, #, \$.
This set is available only as a "special."

2.1.11.4 Special 48 Character Set (IBM Compatible Set)

The character set shall consist of the following 48 printable characters plus a "space" (no print):

The numerals 0 through 9, comma, period, -, *, +, /, \$, #,
%, &, ?, :, and upper case alphabet A through Z. This set
is available only as a "special."

2.1.11.5 Special ASCII 64 Character Set

The character set shall consist of the first 64 characters of paragraph 2.1.11.2; that is, beginning with octal code 040 (space) and ending with octal code 137 (underline).

Within the cartridge, 63 characters are printable, the 64th character being a "space" (no print). The distribution of characters within the 288 positions of the cartridge shall be defined in the cartridge specification 43A174506.

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2.1.12 Examples of Type Array Sets

63 CHARACTER TYPE ARRAY

SET NO.	SLUG POSITION IN SET											
	1	2	3	4	5	6	7	8	9	10	11	12
1	0123	4567	BZ,/	89.-	DUGH	REST	(=')	MNØP	[]?!	VWXY	A:;@	JKQ*
2			CIFL		BZ,/		%\↑←	DUGH	&+<>	MNOP	A\$"#	VWXY
3			JKQ*		CIFL		(=')	BZ,/	[]?!	DUGH	A:;@	MNOP
4			VWXY		JKQ*		%\↑←	CIFL	&+<>	BZ,/	A\$"#	DUGH
5			MNOP		VWXY		(=')	JKQ*	[]?!	CIFL	A:;@	BZ,/
6			DUGH		MNOP		%\↑←	VWXY	&+<>	JKQ*	A\$"#	CIFL

Where not specified, the same type slug used in the first set is used in the remaining five sets.

48 CHARACTER TYPE ARRAY

SLUG POSITION IN SET											
1	2	3	4	5	6	7	8	9	10	11	12
0123	4567	89GH	+-.E	ABCD	RIFL	MNOP	JKQ*	/STU	VWXY	\$&,Z	(=')

This array is made up of six identical sets.

NOTE: See drawing 43A174506 for actual sets.

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2.2.1.4 Slew Character (continued)

- (b) Within the slew character, if the 2⁴th bit is a one, paper shall be slewed under control of the VFU tape hole configurations (refer to paragraphs 2.1.13 and 2.3.3.2).
- (c) In all cases, the slew operation is accomplished after the line has been printed.
- (d) In addition to interrogating the Slew Character for slew information, the Printer Subsystem shall interpret the receipt of a Slew Character as an indication of the completion of the transfer of print line data.

2.2.1.5 Skip Character

If, in the print line data, a single Escape character is followed by a character whose most significant bit (2⁵) is a 1 and whose next most significant bit (2⁴) is a 0, this character following the Escape character is interpreted as a "Skip" character. Upon receiving such a character the Printer Subsystem will insert as many spaces into the print line as indicated by the low-order four bits of the "Skip" character, where these four low-order bits have the following weight.

- 2⁰ bit indicates 8 spaces to be inserted in the print line.
2¹ bit indicates 16 spaces to be inserted in the print line.
2² bit indicates 32 spaces to be inserted in the print line.
2³ bit indicates 64 spaces to be inserted in the print line.

Any configuration of these four bits may be set including a skip of zero spaces.

2.2.1.6 Invalid Data Character

If any character (code) is received which is not represented in the train image buffer, a space will be left where that character would be printed. This condition shall result in a major status of Data Alert with zero substatus.

2.2.2 Non-Edit Mode, Normal (6 Bit) Data

In this mode of operation the Printer Subsystem will, upon receiving a print command, commence requesting print line data characters from the external user system. The Escape and Ignore characters have no special connotation in this mode of operation, and are always printed. The Escape prints as a ! (exclamation point) and the Ignore as a ? (question mark). The Space character will always print as a blank character space.

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2.2.2.1 Termination of the Print Line, Non-Edit Mode

The external user system, in this mode, must signal the completion of the transfer of printline data to the Printer Subsystem by means of a signal on the "End Data Transfer" line (paragraph 2.3.3) because a Slew character (paragraph 2.2.1.4) cannot be recognized by the Printer Subsystem in this mode.

2.2.3 Edit Mode, ASCII Oriented Data

Upon receiving a print command, the printer subsystem will commence requesting a print line of ASCII oriented 9 bit data characters from the external user system. There are several characters which have unique meanings when sent to the printer subsystem as part of the print line of data, and are treated as described in the following paragraph.

2.2.3.1 Horizontal Tabulate Control Character

HT = X00001001 = 011₈

The HT character does not occupy a position on the print line. The character following this control character identifies the address of the last column to be tabbed over.

The number is contained in the low-order 7 bits and must be equivalent to 127₁₀ or less.

If N is the column to be skipped to, then:

128 > N > current column position.

[B] In other words, the tab function shall be valid from left to right on the print line only, and an address of zero designates column 1, an address of 1 designates column 2, an address of 127 designates column 128.

2.2.3.2 Horizontal Column Skip Control Character

US = X00011111 = 037₈

The US character does not occupy a position on the print line. The character following this control character identifies the number of columns to be skipped and left blank (in binary).

The number is contained in the low-order 7 bits and may have any value from 0 to 127.

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2.3 DESCRIPTION OF OPERATION

The transmission of either "Normal" or "ASCII" oriented command to the Printer Subsystem follows the format defined in the Common Peripheral Interface Specification. As defined in paragraph 2.4.1, a command to the Printer Subsystem may call for a slew only operation, a print only operation, a combined print and slew operation, or a Load Image Buffer operation.

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The subsystem shall use identical command codes for both Normal and ASCII oriented commands. The subsystem shall detect the difference by means of the device code. The appropriate device code must be contained in each command.

Device Code 0 = Normal mode (6 bit characters expected).

Device Code 1 = ASCII mode (9 bit bytes expected).

All other device codes are invalid.

2.3.1 Slew Only Operation

Upon the receipt of a slew only command, the Printer Subsystem shall reflect the "Channel/Peripheral Subsystem Busy" status state unless an attention condition prevents acceptance of the command. The Subsystem will then wait until any paper slew operation currently in progress is completed, and then initiate the new slew operation. (Paper will always halt between the two slew operations.) Upon the initiation of the new slew operation, the Subsystem will revert to the "Channel/Peripheral Subsystem Ready" status state, and transmit a Terminate signal to the external user system. At this point the Subsystem is free to accept further commands, the slew operation being concluded off-line.

It is to be noted that the Subsystem will revert to the "Busy" state upon the reception of the slew only command, regardless of whether or not a slew operation is being executed at the time the command is received.

2.3.2 Print/Slew Operation

Upon the receipt of a print/slew command, the Printer Subsystem shall reflect the "Channel/Peripheral Subsystem Busy" status state (unless an attention condition prevents acceptance of the command), and begins requesting print line data characters from the external user system. The Printer Subsystem continues to request and receive print line data characters until either an "End Data Transfer" signal is received from the external user system, or until a "Slew Character" (as defined in paragraphs 2.2.1.4, 2.2.3.3, and 2.2.3.4) is received as part of the print line data. If more than 136 printable characters are received before either the "End Data Transfer" signal or the Slew Character is received, the command execution will be terminated with the Data Alert status, as defined in para. 2.5.1.3b.

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2.3.4 Load Image Buffer Command (Continued)

In the Normal mode, 288 characters must be transferred, whereas in ASCII mode, 432 characters must be transferred across the common peripheral interface. (Paragraph 2.3.5 discusses this further.) The characters transferred shall represent the character codes assigned to each type face of the 288 character train, i.e., a print train image.

The space character, (020) in normal mode and (040) in ASCII, may be loaded into the buffer. The loading of a space character into the image buffer will cause that character position on the train to be ignored and in effect removes that character position from the train. No compare will occur of spaces in the image buffer and spaces in the data buffer.

In ASCII mode, if data sent to the image buffer contains, "Delete" (177), and/or "Shift In" (017) characters or the 2⁷ bit is set, the subsystem shall terminate with a Data Alert with zero substatus.

If the "End Data Transfer" is received by the Subsystem before the Image Buffer is full, the subsystem shall terminate with a Data Alert major status and a zero substatus.

If the subsystem does not receive an "End Data Transfer" after the Image Buffer is full, the subsystem shall not accept additional characters, and shall issue a terminate signal with a Data Alert major status and zero substatus (i.e., Image Buffer Overflow).

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2.3.5 Data Transfer Format, ASCII Mode

ASCII mode is intended, primarily, for 600 line applications. Therefore, the ASCII 8-bit code shall be represented by a 9-bit byte in the 600 memory. The 9-bit byte must then be sent across the common peripheral 6-bit interface, and then re-assembled into a 9-bit byte within the printer subsystem. Therefore, three common peripheral 6-bit characters are required to send two 9-bit ASCII oriented characters to the subsystem. Once received, the 6-bit characters are re-assembled into 9-bit bytes. The high order (2^8) bit is truncated, the 2^7 bit is tested (must be zero), and the 7-bit byte remaining is sent to the Print Line Buffer or Train Image Buffer, along with an odd parity bit generated by the Printer Subsystem.

(a) Characters Received

Char. 1	Char. 2	Char. 3	Char. 4	Char. 5	Char. 6
654 321	654 321	654 321	654 321	654 321	654 321
char. (a)	char. (b)	char. (c)	char. (d)		

9-Bit Bytes Assembled within Subsystem

XX4 321 654	XX1 654 321	XX4 321 654	XX1 654 321
char. 1	char. 2	char. 3	char. 4

Note: The high order bit, in the 9-bit byte, is ignored.
The high order 8th bit must be zero.

- (b) Software shall be responsible for assembling ASCII data into the 9-bit bytes to be interpreted by the Printer Subsystem.

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2.5.1.2 Attention Condition (Continued)

- (a) external user system. No printing will have occurred as a result of the aborted command. The slew operation in progress at the time this condition is detected will be completed.

Commands received by the Printer Subsystem while in this state will be rejected, the "Out of Paper" Attention status being transmitted in response to the command.

- (b) Manual Halt (Encoded as 1 on the 2¹ Information Line)
(See paragraph 3.2.2)

If the Subsystem is in the Channel/Peripheral Subsystem Busy state at the time this condition is detected, the print cycle is completed. Upon the completion of the print cycle, the operation will be terminated with the transmission of the Manual Halt Attention status and a Terminate signal. Any slew operation which is a result of the print command just initiated as terminated, will be completed.

If the subsystem is not busy, but is executing a slew command when this condition is detected, the slew will be completed and the subsystem will revert to the Manual Halt Attention status state.

Commands received by the Printer Subsystem while in this state will be rejected, the "Manual Halt" attention status being transmitted in response to the command.

- (c) VFU Tape Alert (Encoded as 1 on 2² Information Line)
(See paragraph 3.2.3).

If this condition is detected while the Printer Subsystem is in the "Channel/Peripheral Subsystem Busy" state (paragraph 2.5.1), the command execution is immediately terminated, the "VFU Tape" Attention status condition placed upon the appropriate status lines, and the "Terminate" signal (paragraph 2.5.4) sent.

A command received while in this status state will be rejected, the "VFU Tape Alert" Attention status being transmitted in response to the command.

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2.5.1.2 Attention Condition (Continued)

- (c) A slew operation in progress at the time this condition is detected will be aborted.
- (d) Check (Encoded as 1 on the 2³ Information Line) (See Paragraph 3.2.4).

If this condition is detected while the Printer Subsystem is in the "Channel/Peripheral Subsystem Busy" state (paragraph 2.5.1), further printing is inhibited, the "Check" Attention status condition is placed upon the appropriate status lines and the "Terminate" signal (paragraph 2.5.4) is sent.

Commands received while in this status state will be rejected, the "Check" Attention status being transmitted in response to the command.

A slew operation in progress at the time this condition is detected will be completed.

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2.5.1.3 Data Alert

This status return indicates an error condition occurred during the last command execution within the Printer Subsystem. At the time this status condition is sent the Information Lines from the Printer Subsystem (paragraph 2.5.2) will distinguish among the following subclasses of the Data Alert status (see paragraph 3.0 for a definition of each of these conditions):

- (a) Transfer Timing Error (Encoded as 1 on the 2⁰ Information Line) (See paragraph 3.1.1).
- (b) Detected Alert Before Printing Commenced (Encoded as 1 on the 2¹ Information Line) (See paragraph 3.1.2).

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2.5.6 External Reset Line

This line is used to reset the external user system receivers as defined in the Common Peripheral Interface Specification.

3.0 ERROR/INOPERABLE CONDITIONS

The following error/inoperable conditions will be checked for and detected when present.

3.1 DATA ERRORS

3.1.1 Transfer Timing Error

This error is defined as occurring when the external user system fails to respond to a request from the Printer Subsystem for a character within approximately 220 - 460 milliseconds.

3.1.2 Detected Error Before Printing Commenced

The following errors, which occur "before printing commences," are grouped under the above heading:

- (a) Parity error on print line data character received from the external user system.
- (b) Buffer overflow, where 137 printable characters are received from the external user system before either an End Data Transfer signal or a Slew character is received.

It should be noted that the buffer overflow condition will also be detected when, as a result of the reception of a Skip Character (paragraph 2.2.1.5) a print line of more than 136 horizontal positions is implied.

- (c) Transfer Timing error, when the 2^0 bit is also set (1).
- (d) Horizontal Tab Alert

This condition occurs when in ASCII mode and a tab command is issued below the current column address.

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3.1.3 Detected Error After Printing Commenced

The following error which occurs after the physical print operation has been initiated, results in the "Detected Error After Printing Commenced" condition.

Internal parity error, where a parity error is detected on a character within the internal storage buffer of the Subsystem (Train Image Buffer or Print Line Buffer).

3.1.4 Paper Low

This condition is defined as occurring when the supply of paper to the Printer mechanism is about to run out. The condition will be detected far enough in advance so that, after detected on the condition, the page (22 inch form, maximum) being printed may be completed before the "Out of Paper" condition (paragraph 3.2.1) is detected.

3.1.5 Slew Error

[B] This error is defined as the occurrence of approximately 800 to 2200 milliseconds of slewing within a single slew operation.

3.1.6 Top of Page Echo

This condition is defined as occurring whenever paper is slewed to the top of page as a result of a slew command other than an explicit slew to top of page command or slew to top of page slew character.

3.1.7 Invalid Character Code (ASCII Mode Only)

[B] Refer to paragraph 2.2.3.10 (d) and (e) and paragraph 2.2.1.6 and paragraph 2.3.4.

3.2 INOPERABLE CONDITIONS

The following specific inoperable conditions will be detected when present.

3.2.1 Out of Paper

This condition is defined as occurring when paper is slewed to the top of page following the detection of the "Paper Low" condition. Also, this condition will be detected as a result of torn paper, or paper missing from the mechanism.

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4.1.5 Top Page Switch

When actuated, this switch shall result in the slewing of paper to the top of page. The switch shall be illuminated with the color white whenever paper is positioned at the top of page, as determined by the vertical format unit. May operate in either Manual Halt or Operate States, except when in Single Cycle mode.

4.1.6 Single Space Slew Switch

Actuation of this switch shall result in the slewing of paper one line. The switch shall not be illuminated, and shall have a white faceplate. May operate in Manual Halt or Operate States, except in Single Cycle.

4.1.7 Paper Fault Indicator

This condition shall be illuminated red upon the occurrence of "Out of Paper" condition, paper jam, or torn paper.

4.1.8 Fan/Thermal Indicator

The indicator shall become illuminated red when a fan failure or overheat condition within the printer cabinet is detected (90°F or 32.2°C).

4.1.9 VFU Tape Alert Indicator

This indicator shall be illuminated red if the vertical format tape is missing from the printer mechanism, or if a vertical format tape horizontal parity error is detected.

4.1.10 Parity Alert Indicator

This indicator shall be illuminated red upon the detection of a parity error on a data character received from the external user or upon the detection of a parity error on a character in the internal storage buffer of the Printer Subsystem.

4.1.11 Print Alert Indicator

This indicator shall become illuminated red upon the detection of an incomplete printout. An incomplete printout shall be detected when the printer fails to complete a print cycle within approximately 220 - 460 milliseconds after initiation of the print cycle.

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4.2.1 Form Setup Switches

- (a) Under the conditions described in paragraph 4.3.2.1, the actuation of the Print Train switch on the device shall cause the printer to print one line consisting of the first 136 characters.
- (b) Under the conditions described in paragraph 4.3.2.2, the actuation of the "Single Cycle" switch shall cause the Printer Subsystem to go into a Single Cycle mode of operation. In the Single Cycle mode of operation, any print command shall be accepted and executed normally until the termination time is reached. At this time the Printer Subsystem shall remain in the Channel/Peripheral Busy state until either the Single Cycle switch or the Operate/Reset switch is actuated. Actuation of the Single Cycle switch shall cause the printer to terminate the interrupted print command normally but the Printer Subsystem shall stay in the Single Cycle mode of operation. Actuation of the Operate/Reset switch shall cause the printer to terminate the interrupted command normally and shall return the printer to the normal mode of operation. No Special Interrupt is sent in this case.

4.2.2 Switches for Operator Convenience On Back of Printer

On the back of the printer, in an area near the paper stacker and convenient to an Operator, there shall be three switches: Top of Page, Single Cycle Switch, and Operate/Reset switch. The functions and implementation of these switches shall be identical to those on the front operator panel. (See Section 4.3.3.)

4.3 OPERATIONAL DESCRIPTION OF ADDITIONAL OPERATOR CONTROL SWITCHES

The additional operator control switches can be grouped, according to implementation, into two separate sets, described in paragraphs 4.3.1, 4.3.2, and 4.3.3.

4.3.1 Input Control Switches

The input control switches shall be momentary-action indicator-type switches. The input control switches shall have white faceplates.

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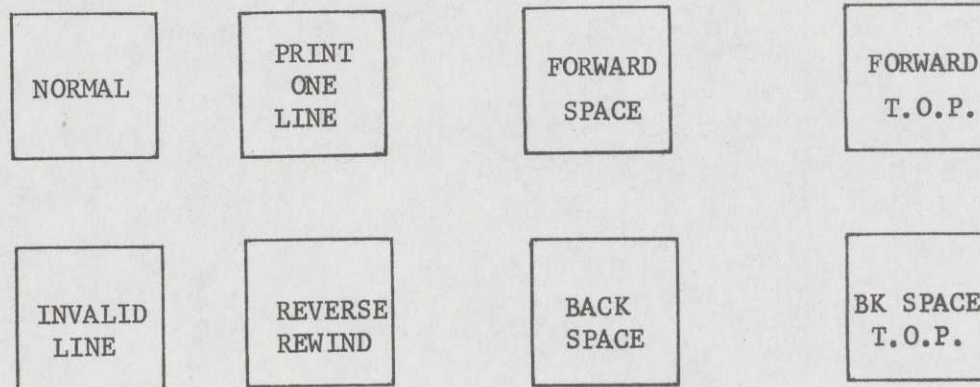
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These input control switches shall be provided on the operators panel and labeled as shown below.



The following table relates the unique substatus associated with each of the input control switches. These switches and functions shall be **OPTIONAL** and mounted on a separate operator panel near the standard operator panel.

<u>Input Control Switches</u>	<u>2⁵</u>	<u>2⁴</u>	<u>2³</u>	<u>2²</u>	<u>2¹</u>	<u>2⁰</u>
Normal	0	0	0	0	0	0
Print One Line	0	0	0	0	0	1
Forward Space	0	0	0	0	1	0
Forward to Top of Page	0	0	0	0	1	1
Invalid Line	0	0	0	1	0	0
Reverse Rewind	0	0	0	1	0	1
Back Space	0	0	0	1	1	0
Back Space to Top of Page	0	0	0	1	1	1

4.3.1.1 In normal operation, the Normal switch shall be illuminated. The Printer Subsystem is defined as being in normal operation at all times other than when the operator is communicating with the software via the input control switches as described in the following paragraph.

4.3.1.2 Actuation of any of the input control switches, other than the Normal switch, when the printer is in the "normal" mode of operation shall cause the following to occur:

- (1) The printer shall complete any command execution in progress and shall then revert to the Manual Halt mode.
- (2) The Normal switch shall become dark.

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4.3.1.2 Input Control Switches (Continued)

- (3) The Halt switch shall become illuminated.
- (4) The substatus associated with the actuated switch shall be stored in the Printer Subsystem.
- (5) The actuated switch shall become illuminated.
- (6) The Operate indicator shall become dark and the Reset indicator shall be illuminated.

4.3.1.3 When the Printer Subsystem is not in the normal operation mode and has stored substatus, as described above, the actuation of another input control switch shall cause the following to occur:

- (1) The substatus stored by the previously actuated input control switch shall be reset.
- (2) The previously actuated input control switch shall become dark.
- (3) The substatus associated with the input control switch just actuated shall be stored.
- (4) The input control switch just actuated shall become illuminated.

4.3.1.4 Anytime that the Printer Subsystem is in the Manual Halt mode with stored substatus, and no other attention condition exists, the actuation of the Operate/Reset switch shall cause the following:

- (1) The Printer Subsystem shall return to the operate state.
- (2) The Operate field of the Operate/Reset switch shall become illuminated (green).
- (3) The Halt switch shall become dark.
- (4) A Special Interrupt shall be transmitted to the external user.

4.3.1.5 If the external user answers the Special Interrupt with a Request Status command, the following shall occur:

- (1) The status of Channel/Peripheral Ready and the unique substatus stored in the Printer Subsystem shall be transmitted to the external user.
- (2) The stored substatus shall be reset.

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4.3.1.5 Input Control Switches (Continued)

- (3) The illuminated input control switch shall become dark, the only exception being the Normal switch as described below.

4.3.1.6 The operator-software communication method provided (by the input control switches) allows the operator to make several requests of software before normal printing actually resumes. The software shall be implemented so that normal printing will not resume until a Special Interrupt is received by the external user along with a major status of Channel/Peripheral Ready with substatus of all zeros.

Once the operator has made all of his requests of the software, he will actuate the Normal switch. This shall cause the following to happen:

- (1) The printer shall complete any command execution in progress and shall then revert to the Manual Halt mode.
- (2) The Normal switch shall become illuminated.
- (3) The Halt switch shall become illuminated.
- (4) The substatus of all zeros shall be stored in the Printer Subsystem.
- (5) The Operate indicator shall become dark, and the Reset indicator shall be illuminated.

It should be noted that the actuation of the Normal switch when the printer is in the normal operation mode shall have the same effect as described above.

As described previously, the subsequent actuation of the Operate/Reset switch shall cause the transmission of a Special Interrupt to the external user.

NOTE: The reception of a Request Status Command, when substatus of all zeros stored, shall not cause the Normal switch to become dark.

4.3.1.7 As can be seen in the above, the Normal switch shall be illuminated until such time as one of the other input control switches is actuated to establish operator-software communication. The Normal switch shall stay dark until such time as the operator concludes the communication by actuating the Normal switch. The actuation of the Operate/Reset switch also shall be necessary in order to transmit the Special Interrupt to the external user.

When in the Manual Halt mode, the Slew Top of Page and Single Line Slew switches shall be responsive and slewing will result when they are actuated.

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4.3.1.8 600 Software Interpretation

A brief summary of switch procedures, from an operator point of view, is as follows:

- a) To communicate with the 600:
 - (1) Actuate the desired function switch; "Print One Line," "Forward Space," "Backspace," etc. (one switch only).
 - (2) Actuate the "Operate/Reset" switch to send appropriate status to the 600.
 - (3) Repeat the sequence of (1) and (2) each time a switch is actuated. Software does not execute the functions until the operator executes the sequence of paragraph b.
- b) To end communication with the 600, and cause software to perform the desired functions.
 - (1) Actuate the "Normal" switch.
 - (2) Actuate the "Operate/Reset" switch.
- c) The responses of 600 Software, as currently implemented, are outlined in the following table:

NORMAL/HALT (00)

This control releases the printer from the manual halt model. Pressing NORMAL and OPERATE/RESET causes normal printing to resume.

PRINT ONE LINE (01)

This control prints *PRINT 1 LINE and the next line of data. It leaves the printer in manual halt mode.

FORWARD SPACE (02)

This control causes printing of **OPERATOR KILLED THIS REPORT and SYSOUT proceeds to the next report.

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4.3.1.8 600 Software Interpretation (continued)

FORWARD T.O.P. (03)

This control prints *FORWARD SPACE T.O.P., causes spacing to the beginning of the next data block and leaves the printer in manual halt mode. If printing an execution report, normal printing resumes automatically.

INVALID LINE (04)

This control prints the message **INVALID LINE** and leaves the printer in the manual halt mode. If the NORMAL and OPERATE RESET switches are actuated, printing resumes at the next line after the invalid line.

REVERSE REWIND (05)

This control prints **OPERATOR RESTARTED THIS REPORT and SYSOUT automatically restarts the report in progress.

BACKSPACE (06)

This control prints *BACKSPACE and leaves the printer in the manual halt mode. If the BACKSPACE switch is actuated only once, and the NORMAL and OPERATE RESET switches are actuated, printing resumes with the line just printed. If printing an execution report, printing automatically resumes at the beginning of the report.

BK. SPACE T.O.P. (07)

This control prints *BACKSPACE T.O.P. and reprints information starting at the beginning of the current block of data. After actuating the NORMAL and OPERATE/RESET switches, the printer resumes normal printing. If printing an execution report, printing resumes at the beginning of the report.

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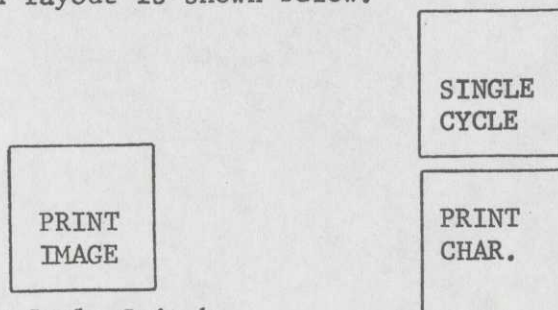
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These switches facilitate printing one line at a time in either the "off-line" or "on-line" mode. The off-line mode shall be defined as printing the first 136 characters contained in the Train Image Buffer, or printing a complete line of identical characters. The on-line mode shall be defined as printing data received from the external user.

Penetration controls shall be provided to allow an operator to pre-set print density for each size forms pack.

The Print Image switch, the Print Character switch, and the Single Cycle switch shall be momentary-action indicator-type switches. The Print Image and Print Character switches shall have a white faceplate and shall be dark. The Single Cycle switch shall be illuminated blue whenever the printer is in the single cycle mode.

The form set-up switches shall be logically grouped on the operator panel. A suggested layout is shown below.

(a) Single Cycle Switch

Enables an operator to print one line and stop. If the subsystem is on line, a terminate is not sent to the external user system, and status reflected remains channel busy.

(b) Print Character Switch*

Actuation of this switch causes a complete print line, of 136 identical characters to be printed out, as determined by code set by the Fault Isolation Panel switches and the image codes present.

(c) Print Image Switch*

Actuation of this switch causes the first 136 characters, of the Train Image Buffer, to be printed out.

*NOTE: The subsystem must be in the Manual Halt state for these switches to be functional.

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4.3.2.1 Printing in the Off-Line Single Cycle Mode

The actuation of the Print Train or print character switches when the printer is in a Manual Halt condition, shall cause the following:

- 1) The Print Train or print character indicator shall become illuminated.
- 2) A line of characters shall be printed.
- 3) Upon completion of the print cycle, the indicators shall become dark.
- 4) No slew shall result.

In the off-line mode, the actuation of the Print Train or print character switch shall not cause slewing. If slewing is desired, the operator must actuate the Slew One Line switch or the Slew to Top of Page switch.

4.3.2.2 Printing in the On-Line Single Cycle Mode

If the printing of a line is in progress and the Single Cycle switch is actuated, the Single Cycle mode shall be set and the line in progress shall be printed; however, the Channel/Peripheral Busy status shall not be reset nor shall the Terminate be issued. In addition, the slewing associated with the line in progress shall not be executed at this time.

If a print command execution is interrupted by the Single Cycle mode as described above, actuating the single cycle switch again shall cause the Terminate to be issued and termination status to be issued. In addition the slewing associated with the line in progress shall take place.

As the printer is still in the Single Cycle mode, the next data line received from the external user shall be printed as above, but the Terminate shall not be issued nor shall the Channel/Peripheral Busy status be reset. In addition the slewing associated with the line in progress shall not be executed at this time.

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4.3.2.2 Printing in the On-Line Single Cycle Mode (continued)

[B] Actuation of the Operate/Reset or Manual Halt switch shall, provided the printer is not already in an Attention condition, reset the Single Cycle mode and the interrupted print command in execution shall be completed. No special interrupt shall be sent to the processor when the Operate/Reset switch is used to reset the Single Cycle mode.

When the Single Cycle mode has been reset, future lines shall be printed normally.

If the printing of a line is not in progress and the Single Cycle switch is actuated, the Single Cycle mode shall be set, and the executing of the printing of the next data line received shall be interrupted as described in this section.

[B] When the printer is in an attention condition, other than MANUAL HALT, the actuation of the Single Cycle switch shall set the Single Cycle mode. The subsequent actuation of the Operate/Reset switch shall reset the attention condition (providing the attention condition has been corrected), return the printer to the operate state, cause a Special Interrupt to be issued, and leave the Single Cycle mode set. This feature allows for printing the first line, following the loading of new forms or the correction of an attention condition, in the Single Cycle mode.

[B] When in the Single Cycle mode (both on-line and off-line), opening and closing the print gate shall not change status; however, if the print gate is still open, actuation of either the Print Train switch or the Single Cycle switch shall have no effect.

[B] If it is attempted to return the printer to the operate state, with the print gate open, the Printer Subsystem shall revert to the attention state.

For operator safety, the train cartridge area shall have an interlock which will shut off the typeline motor when the door is opened by the Operator.

4.3.3 Operator Panel Layout

[B] For the CDC Train Printer, the following represents a suggested layout of the two operator panels.

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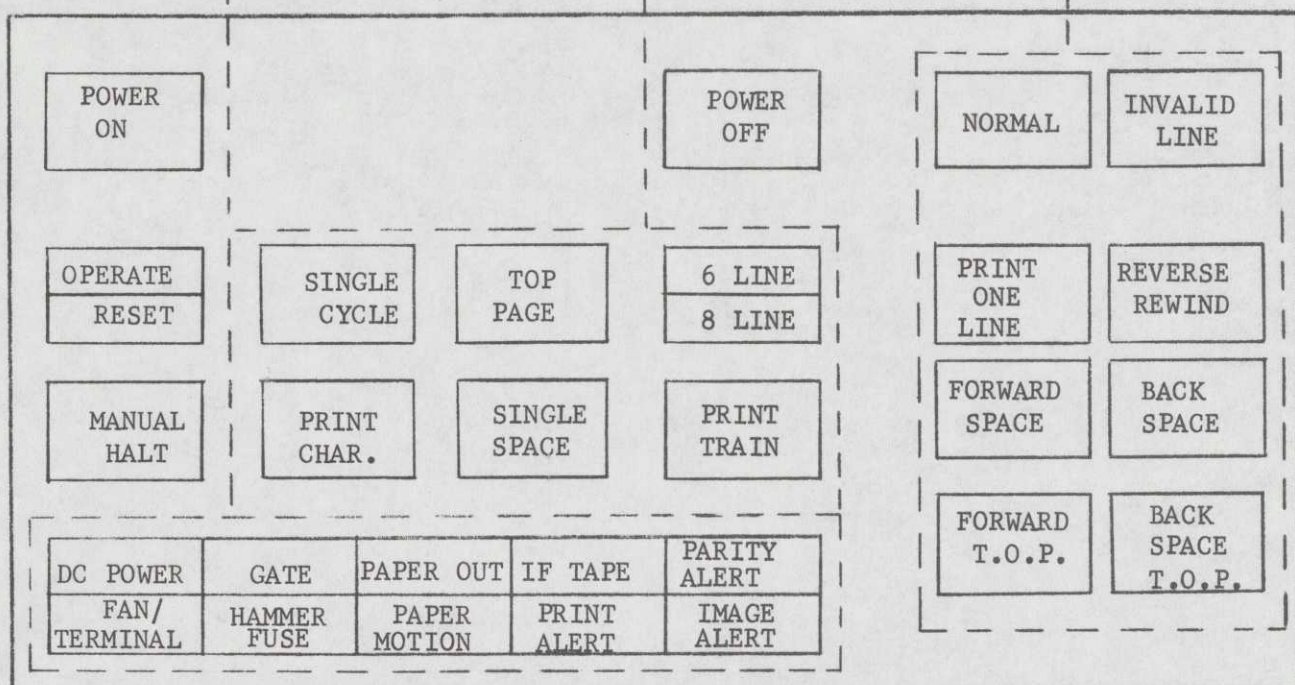
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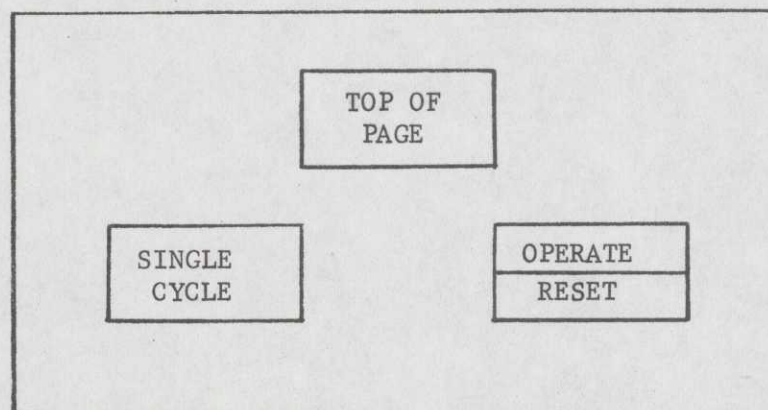
4.3.3 Operator Panel Layout (cont.)

Error Indicator Switches

Setup Switches

Input Control
Switches

FRONT CONTROL PANEL



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5.0 RELIABILITY, MAINTAINABILITY AND ACCURACY

The reliability, maintainability and accuracy requirements of this specification assume the performance of repair and specified preventive maintenance activities by trained and experienced personnel.

The maintainability requirements assume the availability of adequate maintenance functions and aids, which shall be built into the printer subsystem.

When accomplishing off-line maintenance, it shall be possible to diagnose, repair, and perform adjustments without interrupting the external user system. Maintenance aids shall be capable of diagnosing 80% or more of all failures within the subsystem to a replaceable parts level for immediate repair.

A subsystem failure is defined as a failure in either the controller or the printer mechanism.

5.1 RELIABILITY

5.1.1 Definitions

5.1.1.1 Printer Operator Time

Printer Operator Time is defined as all active printer time. It includes printing, slewing, paper changing time, ribbon and V.F.U. tape replacement time, operator adjustment time, etc. It does not include printer idle time.

5.1.1.2 Definition of Configuration

The printer subsystem shall consist of a single controller and a single printer mechanism with a standard 63 character set train cartridge. An average 600 system shall be defined as having 2.0 printers.

5.1.1.3 Failure Definition

A failure shall be charged against any hardware segment when its function is impaired such that productive processing is stopped and an unscheduled repair action is required to restore the system or subsystem to an operable condition.

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5.1.2 Power-On Relations

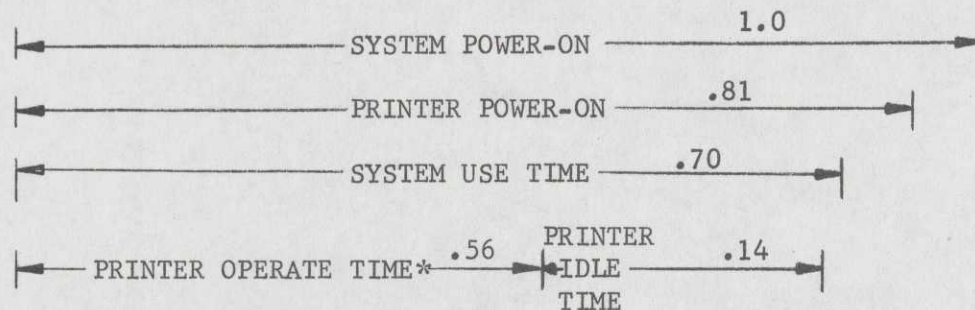
For purposes of this specification, power-on time shall assume that the controller and the mechanism always have power on simultaneously.

$$\frac{600 \text{ System Use Time}}{600 \text{ System Power-On}} = 0.70$$

$$\frac{\text{Printer Subsystem Use}}{600 \text{ System Power-On}} = 0.56$$

$$\frac{\text{Printer Subsystem Power-On}}{600 \text{ System Use}} = 1.17$$

$$\frac{\text{Printer Operate Time}}{600 \text{ System Use Time}} = 0.80$$



5.1.3 Printer Requirements System Level

5.1.3.1 Duty Cycles

The 600 system application of the PRT300 subsystem is as follows:

- a. 600 - system environment
 - . 17.2 shifts per week
 - . 4.33 weeks per month
 - . 8 hours per shift
- b. Printer subsystem application in 600 - system.
 - . Configuration as defined in 5.1.1.2
 - . Average 24% columns printed per page
 - . Average 30% lines printer per page
 - . 15,200 lines per system-use hour for the primary printer*
 - . 11,100 lines per system-use hour for the secondary printer*
 - . 13,150 lines per system-use hour for average use*

*Developed from field use survey "Printer Stress in a 600 System Environment," June 16, 1970.

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5.1.3.2 Reliability Requirements

The MTBF of the PRT300 subsystem, while operating with the 600 system and with the duty cycle of paragraph 5.1.3.1.b, shall be as follows:

$$\text{MTBF} = \frac{\text{System Use Time}}{\text{Failures}}$$

375 hours	Step 4 Review
460 hours	Step 5 Review
530 hours	24 months after first delivery (maturity)

The MTBF at the system level shall be demonstrated at a 50% confidence level at Step 4 and 90% confidence level at Step 5.

5.1.4 Printer Requirements Subsystem Level Independent of 600 System

This requirement is to be used as a reference for Step 4 Review and is derived from system use.

5.1.4.1 Duty Cycle

- . Configuration as defined in 5.1.1.2
- . Average 24% columns printed per page
- . Average 30% lines printed per page
- . 16,200 lines per operating hour
- . Print rate 33% of rated lines per minute

5.1.4.2 Reliability Requirements

The MTBF of the PRT300 subsystem, while operating independent of the 600 system defined in paragraph 5.1.4.1, shall be as follows:

$$\text{MTBF} = \frac{\text{Subsystem Operate Time}}{\text{Failures}} = 300 \text{ hours}$$

The MTBF at the subsystem level shall be demonstrated at 50% confidence prior to first shipment.

5.1.5 Peak Load

During normal operation of the subsystem, there will be periods of peak demand. The peak load for this subsystem shall be assumed to extend over a 4 hour period. The 90th percentile of the printer speed shall be 37,300 lines per hours.

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5.2 ACCURACY AND LIFE

5.2.1 Error Rate

Error conditions shall be limited to the following frequency per duty cycle of 5.1.3.1 and 5.1.3.2.

- (a) A maximum of one detectable error per 1,000,000 lines at 136 characters per line with a confidence level of 80%.
- (b) A maximum of one non-detectable error per 50,000,000 lines at 136 characters per line with a confidence level of 80%.
- (c) A detectable error is defined as any error attributable to a malfunction of the Printer Subsystem that is detected by error detection circuitry, and that caused an error status condition to be signaled to the external user system.
- (d) A non-detectable error is defined as any error attributable to a malfunction of the printer subsystem that is not detected by the error detection circuitry. A non-detectable error will result in an erroneous printout (e.g., the loss of data, changing of data, improper line spacing).

Failures caused by worn ribbons or worn VFU loops are excluded from this definition.

5.2.2 Ribbon Life

Ribbon life is largely dependent on the nature of the printing being done. Nevertheless, ribbon life shall be in excess of 400,000 printed lines for a normal nylon ribbon. Special ribbons shall be available with a ribbon life of 1×10^6 printed lines. Ribbon replacement shall be accomplished by an operator.

5.2.3 VFU Loop Life

Mylar Vertical Format loops, when properly prepared, shall provide a minimum of 200 hours useful service. VFU loop replacement shall be accomplished by an operator.

5.2.4 Subsystem Life

With appropriately defined periodic maintenance and scheduled parts replacement, the printer subsystem shall have a minimum useful life of 20,000 power on hours, or seven years, assuming the average duty cycle defined in paragraph 5.1.3.1.

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5.3 MAINTENANCE

5.3.1 Scheduled Maintenance

Scheduled maintenance (Preventive Maintenance) is that time periodically reserved in advance to perform tasks required to minimize the probability of equipment failures.

Scheduled maintenance for the subsystem shall occur at 150 power on hour intervals or 2.4 million lines and shall require no more than 1 hour to accomplish.

Scheduled major overhauls and major parts replacement shall not exceed one 6 hour interval for every 2000 printer power on hours.

5.3.2 Unscheduled or Emergency Maintenance

Unscheduled or Emergency Maintenance (E.M.) is usually measured by Mean Time to Repair (MTTR). MTTR is derived by averaging repair times. For this specification, MTTR shall be defined as follows:

- (a) Diagnostic Time
- (b) Replacement and/or adjustment time
- (c) Checkout time

The following items shall be excluded from the MTTR requirement:

- (a) Travel time to the site by field personnel
- (b) Logistic time
- (c) Rerun time

Under these conditions, the MTTR shall be 1.2 hours at Step 5 and 1.0 hour one year after Step 5 at a 90% confidence level. 90% of the failures shall have a time to repair of less than 2.2 hours at Step 5 and 1.85 hours at maturity.

5.3.2.1 System Effects of E.M.

Unscheduled maintenance requirements shall not result in more than four (4) hours of system down time per 530 hours of usage time with on-site maintenance personnel and spare parts.

5.3.3 Maintenance Equipment

The necessary product tools and test equipment unique to this subsystem, and other maintenance aids required to achieve the maintenance objectives of this specification, shall be provided by the producing department.

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5.3.4 Spare Parts

Field Engineering shall provide a minimum quantity and variety of replacement spare parts (initial spare parts shall be furnished by the Producing Department) and adequately trained maintenance personnel, either on-site or on-call, in order to maintain printer subsystem availability in conformance with paragraphs 5.3.2 and 5.3.2.1.

5.3.5 Instruction Books

Instruction Books shall be provided by the Producing Department for site maintenance.

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 5.3.6 Meters5.3.6.1 Elapsed Time Meter

An elapsed time meter shall be provided for measurement of POWER ON time of the subsystem. It shall have a range of 9,999.9 hours (minimum).

5.3.6.2 Print Actuation Meter

A meter shall be provided to measure the actual number of lines printed by the subsystem. It shall have a range of 99,999,999 print lines (minimum).

5.4 PRINTING REQUIREMENTS

The following printing requirements shall be required on the original copy (first part) of the forms discussed in paragraph 2.1.19.2.

5.4.1 Type Font

The Producing Department shall design and/or provide a standard type font which enhances print quality by taking advantage of the unique characteristics of the horizontally moving type slug. In addition, the type font shall be designed for maximum legibility on the last part of a six part form. (See paragraph 2.1.19.2.) In particular, the type font shall be designed so that "ambiguous" characters can be clearly recognized as unique characters on the final part of multipart forms; e.g., B and 8, O and Q, et al. Type fonts are referenced in GE drawing number 43A174506.